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MILITARY SPECIFICATION

ADHESIVE, FILM FORM, METALLIC STRUCTURAL SANDWICH CONSTRUCTION

This specification is approved for use by all
 Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the requirements for adhesives in film form for bonding metal facings to metal cores and to metal components of sandwich panels which are intended for use in primary and secondary structural airframe parts that may be exposed to temperatures up to 500°F (260°C).

1.2 Classification. The adhesive shall be furnished in the following types, classes and cure groups as specified (see 6.2).

1.2.1 Types.

- | | | |
|----------|---|--|
| Type I | - | For long-time exposure to temperatures from -67° to +180°F (-55° to +82°C). |
| Type II | - | For long-time exposure to temperatures from -67° to +300°F (-55° to +149°C). |
| Type III | - | For long-time exposure from -67° to +300°F (-55° to +149°C) and short-time exposures from 300° to 500°F (149° to 260°C). |
| Type IV | - | For long-time exposure from -67° to +500°F (-55° to +260°C). |

1.2.2 Classes.

- | | | |
|-----------|---|--|
| Class 1 | - | For bonding metal facings to metal cores only. |
| • class 2 | - | For bonding metal facings to metal cores, inserts, edge attachments and other components of completed sandwich structures. |

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Engineering Specifications and Standards Department (Code 93), Naval Air Engineering Center, Lakehurst, NJ 08733, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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1.2.3 Cure temperature groups.

- Group 1 - Cure temperature 100°F or less
- Group 2 - Cure temperatures over 100°F to 200°F
- Group 3 - Cure temperatures over 200° to 300°F
- Group 4 - Cure temperatures over 300°F

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. Unless otherwise specified, the following specifications, standards, and handbooks of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation form a part of this specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

- QQ-A-250/4 - Aluminum Alloy 2024, Plate and Sheet
- MMM-A-132 - Adhesive, Heat Resistant, Airframe Structural, Metal to Metal
- PPP-B-601 - Boxes, Wood, Cleated Plywood
- PPP-B-636 - Boxes, Shipping, Fiberboard

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- MIL-T-5624 - Turbine Fuel, Aviation, Grades JP-4 and JP-5
- MIL-C-7438 - Core Material, Aluminum, For Sandwich Construction
- MIL-B-22191 - Barrier Material Transparent, Flexible Heat Sealable
- MIL-S-25043 - Steel Plate, Sheet and Strip, 17-7 PH Corrosion Resistant, Precipitation Hardening.
- MIL-A-83377 - Adhesive Bonding (Structural) For Aerospace and Other Systems, Requirements for

STANDARDS

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- MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes
- MIL-STD-129 - Marking for Shipment and Storage

(Copies of specifications, standards, handbooks, drawings and publications required by manufacturers in connection with specific acquisition functions should be obtained from the acquisition activity or as directed by the contracting officer.)

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2.2 Other publications. The following documents form a part of this specification to the extent specified herein. The issues of the documents which are indicated as DoD adopted shall be the issue listed in the current DoDISS and supplement thereto, if applicable.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- | | |
|------------------------------------|--|
| ASTM C 297-61
(Reapproved 1976) | - Tension Test of Flat Sandwich Constructions in Flatwise Plane. |
| ASTM C 393-62
(reapproved 1976) | - Flexure Test of Flat Sandwich Constructions. |
| ASTM D 1781-76 | - Climbing Drum Peel Test for Adhesives. |

(Applications for copies should be addressed to the American Society for Testing and Materials, 1916 Race St., Philadelphia, PA 19103).

UNIFORM CLASSIFICATION COMMITTEE, AGENT

Uniform Freight Classification.

(Application for copies should be addressed to the Uniform Classification Committee, Room 1106, 222 South Riverside Plaza, Chicago, IL 60606.)

NATIONAL MOTOR FREIGHT TRAFFIC ASSOCIATION, INC., AGENT

National Motor Freight Classification.

(Application for copies should be addressed to the National Motor Freight Traffic Tariff Order Section, 1616 P Street, N. W., Washington, DC 20036).

(Industry association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

3. REQUIREMENTS

3.1 Qualification. Adhesives furnished under this specification shall be products which are qualified for listing on the applicable qualified products list at the time set for opening of bids (see 4.3 and 6.3).

3.2 Material. The adhesive shall be thermosetting and shall meet the strength requirements of this specification. The adhesive shall not have a deleterious effect on the metal surfaces being bonded over the range of temperatures at which the adhesive will be used. There shall be no restrictions on the ingredients used in the adhesive other than those imposed by the technical requirements specified herein. Class 2 adhesives shall consist of an adhesive conforming to MMM-A-132, as applicable to the type, plus the requirements specified herein.

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3.2.1 Formulation changes. The adhesive shall be approved only for the formulation on which qualification tests are made. Any changes by the manufacturer, such as the adding of fillers, change in carrier, method of manufacture or change in weight per square foot in excess of the tolerance specified in 3.2.2 shall be cause for designating the adhesive as a new product which shall not be considered approved. The changed adhesive shall be given a new code number and shall be resubmitted for approval under this specification.

3.2.2 Identification of product. The manufacturer shall identify each product submitted under this specification according to its type, class, and cure group. The manufacturer shall also specify the medial weight, within a range of + 20 percent (see 3.2.3), and the carrier, when applicable (see 3.2.3). In addition, the manufacturer shall designate each adhesive by a trade name and code number which shall be used to identify formula and batch.

3.2.3 Form. The adhesive shall be film form and shall consist either entirely of adhesive or of a carrier impregnated with adhesive. The film weight (in pounds per square foot to the nearest 0.001 pound) shall be stated. Film adhesives of a given type and composition manufactured in more than one weight range shall be submitted for separate testing and qualification approval. Films within a range of + 20 percent of the medial weight shall be considered within one weight range when more than two weight ranges of a product are available. Approval of both the maximum and minimum weight products will then convey automatic approval of products of same type and composition with weights between the maximum and minimum.

3.2.4 Primer. A liquid primer may be furnished and used with the adhesive in film form. The primer shall be considered an integral part of the adhesive system and shall be identified on the Qualified Products List.

3.3 Working characteristics.

3.3.1 Application. The adhesives shall be suitable for application to metal facings and core materials in accordance with the manufacturer's instructions at temperatures between 65°F and 85°F (18.3°C and 29.4°C) and at a maximum relative humidity of 60 percent.

3.3.2 Curing. The time, temperature and pressure used to cure the adhesive shall be within the range specified herein.

3.3.2.1 Curing times and temperatures. Maximum time to fully cured state for the cure groups in 1.2.3 shall be as follows:

- Group 1 - 7 days at 100°F or less
- Group 2 - 24 hours at over 100°F to 200°F
- Group 3 - 2 hours at over 200°F to 300°F
- Group 4 - 2 hours at over 300°F

Additionally, types I and II adhesives shall require not longer than 2 hours for curing at temperatures not exceeding 350°F (177°C) at the adhesive line. Types III and IV shall cure/postcure at temperatures not to exceed 600 F (316°C) at the adhesive line.

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3.3.2.2 Curing pressure. In the preparation of sandwich constructions fabricated in accordance with 4.3.4, the pressure required for curing the adhesive shall not exceed the rated psi for the core construction.

3.4 Storage life. The adhesive manufacturer shall determine the longest period of time from date of manufacture and the maximum temperature which the adhesive system, when stored in airtight containers or wrapped in suitable vapor barriers, will retain its capabilities of meeting the minimum strength requirements specified in 3.5. These storage conditions shall be included in the instruction sheet (see 3.6) and the test report (see 4.3.2.2).

3.5 Mechanical properties.

3.5.1 Class 1. When tested in accordance with the applicable paragraph in section 4, class 1 adhesive shall be not less than the minimum average and minimum individual values specified for all tests in table I, as applicable to the type.

3.5.2 Class 2. The mechanical properties of class 2 adhesives shall conform to those specified in MMM-A-132, as applicable to the type. In addition, when tested in accordance with section 4, class 2 adhesives shall not be less than the minimum individual values specified for all tests in table I, as applicable to the type.

3.6 Instruction sheet. A dated, coded and titled instruction sheet, outlining instructions for use of the adhesive, shall be supplied by the manufacturer. The instructions shall be forwarded with the test report when requesting qualification (see 4.3.2). In addition, the instruction sheet shall accompany each shipment of adhesive (see 5.3). The following information shall be included:

- a. The general chemical type of the basic resin used in the adhesive, such as phenolic-chloroprene or vinyl-phenolic, etc. The type and treatment of the carrier.
- b. Storage information required in 3.4
- c. Complete recommended metal preparation.
- d. Application instructions, including primer film thickness range, temperature and relative humidity, if other than specified in 3.3.1.
- e. Maximum allowable shelf life interval of the primer coated metal prior to adhesive application and any primer reactivation procedure, if applicable.
- f. Maximum allowable storage life of adhesive coated metal prior to assembly and curing, and the maximum storage temperature.
- g. Recommended maximum time, temperature and pressure for each segment of the complete curing cycle and the number of permissible re-cures for multiple bonding of assemblies.
- h. The necessary safety precautions to be taken when using the adhesive and any related primer.

3.7 Workmanship. The film adhesive shall be free of folds, foreign matter and wrinkles, and shall not have more than two holes of 1/8 inch maximum diameter per square inch which penetrate through the film.

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4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Classification of inspection. The inspection requirements specified herein are classified as follows:

- a. Qualification inspection (see 4.3).
- b. Quality conformance inspection (see 4.4).

4.3 Qualification inspection. The qualification inspection shall consist of all the tests specified in table II.

4.3.1 Qualification test samples. Qualification test samples shall consist of test specimens bonded as specified in 4.3.4 through 4.3.4.4.2 prepared from 30 square feet of adhesive film. The film shall be packaged as specified in section 5. Included as part of the sample shall be the adhesive primer, if required. All specimens and the remaining film shall be forwarded to the Qualifying Laboratory - Commander, Naval Air Development Center, Warminster, PA 18974, Attention: ACSTD (Code 6062). The sample (test specimens and adhesive film) shall be plainly and durably marked with the following information:

SAMPLE (SPECIMEN OR ADHESIVE FILM) FOR QUALIFICATION TESTING

ADHESIVE, FILM FORM, METALLIC STRUCTURAL SANDWICH CONSTRUCTION
 Type, class, cure group.
 Name and address of manufacturer.
 Plant address and date adhesive film was produced.
 Manufacturer's code number or identification.
 Submitted by (name) for qualification in accordance with the
 requirements of MIL-A-25463B under authorization (reference
 authorizing letter).

4.3.2 Manufacturer's data.

4.3.2.1 Test reports. Two copies of the manufacturer's certified test report shall be forwarded with the qualification sample. The report shall show, by actual test results and specific paragraph references, the adhesive film submitted conforms to all the requirements of this specification.

4.3.2.2 Instructions for use. The manufacturer shall submit 2 copies of the instruction sheet specified in 3.4.

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4.3.3 Retention of qualification. In order to retain qualification of a product approved for listing on the Qualified Products List (QPL), the manufacturer shall verify by certification to the qualifying activity that the manufacturer's product complies with the requirements of this specification. The time of periodic verification by certification shall be in two-year intervals from the date of original qualification. The Government reserves the right to re-examine the qualified product whenever deemed necessary to determine that the product continues to meet any or all of the specification requirements.

4.3.4 Test specimen preparation.

4.3.4.1 Sandwich panel weight. The total weight of the adhesive systems (both facings) shall be the minimum recommended by the adhesive manufacturer, +5, -0 percent and shall not exceed 0.250 pounds per square foot (psf) for types I and II or 0.40 psf for type III or IV adhesives.

4.3.4.2 Peel test specimens. A sufficient number of sandwich panels shall be prepared to yield 18 - 3 by 12-inch specimens for peel testing. The panels shall be prepared with 0.020 + 0.002-inch, 2024-T3 aluminum facings conforming to QQ-A-250/4 bonded to 0.50-inch thick aluminum core conforming to code 7.9-1/4-40(5052) of MIL-C-7438 using the adhesive system undergoing test. The panels shall be fabricated and cut so that the ribbon direction of the core is the same as the 12-inch dimension of the test specimen. All specimens shall then have one facing undercut at both ends and the core and the cut facing removed as shown in figure 1.

4.3.4.3 Specimens for flatwise tensile tests. At least 18 sections of core measuring 2 by 2 inches shall be cut for bonding to two - 2-inch by 2-inch by 1.5-inch thick loading blocks. The dimensions of the specimens shall be measured to at least 0.5 percent accuracy. For types I and II adhesives, the specimens shall consist of 0.50-inch thick aluminum core conforming to MIL-C-7438, code 7.9-1/4-40(5052), bonded directly with the adhesive submitted for qualification to 2024-T4 aluminum alloy loading blocks conforming to QQ-A-250/4. For types III and IV adhesives, the specimens shall consist of honeycomb core with continuous welded nodes bonded directly with the adhesive submitted for qualification to stainless steel loading blocks conforming to MIL-S-25043, type 17-7PH, condition TH 1050. The honeycomb core shall be 0.50-inch thick, 0.25 inch cell size, nonperforated 0.002-inch foil size, fabricated from stainless steel conforming to MIL-S-25043, type 17-7PH, condition TH 1050. In lieu of stainless steel welded core, cores with adhesive-bonded nodes may be used, but it shall be so specified in the test report. The node-bonding adhesive shall be either the adhesive being submitted for qualification or an equivalent type conforming to MMM-A-132. The bolt holes in the loading blocks shall be 0.375-inch in diameter and the axis of the hole shall be parallel to the bonding face, 1.0 + 0.020-inch from the bonding face, and equidistant (tolerance + 0.02-inch) between the adjacent sides. Each specimen shall be assembled the holes in the two loading blocks on opposite sides of the core are at 90 degrees to each other and the sides of the blocks are in alignment (maximum effect tolerance of 0.015-inch) as shown in ASTM D 297.

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4.3.4.4 Panels for flexure and creep tests. A sufficient number of sandwich panels shall be prepared to provide at least forty-eight 3-inch by 8-inch specimens for each type. All test specimens shall be cut from the panels so that the ribbon direction "L" of the cores is the same as the 8-inch lengthwise dimension of the specimen.

4.3.4.4.1 Types I and II adhesives. Sandwich panels shall be prepared using 0.063 ± 0.003 inch, 2024-T3, aluminum facings conforming to QQ-A-250/4, bonded to 0.50-inch thick aluminum core conforming to MIL-C-7438, code 7.9-1/4-40(5052). Core materials for use with type II adhesives shall be node bonded with the adhesive submitted for qualification or an equivalent type conforming to MMM-A-132.

4.3.4.4.2 Types III and IV adhesives. Sandwich panels shall be prepared using 0.050 ± 0.005 -inch, type 17-7PH, condition TH 1050 stainless steel facings conforming to MIL-S-25043 bonded to honeycomb core with continuous welded nodes (see 4.3.4.3 for exception to core with continuous welded nodes). The core shall be 0.50-inch thick, 0.25-inch cell size, nonperforated, 0.002-inch foil size, fabricated from condition TH 1050, stainless steel conforming to MIL-S-25043.

4.3.5 Identification of specimens. All panels and specimens shall be numbered in such a manner as to identify the adhesive and components in order to permit rapid discernment of failure patterns which may result from poor bonding or mechanical equipment failure.

4.4 Quality conformance inspection.

4.4.1 Lot formation. A lot shall consist of all the adhesive film of one type, class, and cure group, forming part of one contract or order, manufactured from the same batch of adhesive (see 6.5) and submitted for inspection at the same time and place.

4.4.2 Sampling.

4.4.2.1 For visual inspection. All film shall be visually inspected as specified in 4.4.3.1.

4.4.2.2 For physical property tests. Five square feet of film shall be randomly selected from each lot and inspected as specified in 4.4.3.2.

4.4.2.3 Packaging.

4.4.2.3.1 Unit package. A random sample of unit containers shall be selected from each lot in accordance with inspection level I of MIL-STD-105 and inspected as specified in 4.4.3.3. The sample unit shall be one unit package. The lot size shall be the number of unit containers.

4.4.2.3.2 Shipping containers. Shipping containers, just prior to closure, shall be randomly selected from each lot in accordance with inspection level I of MIL-STD-105 for inspection as specified in 4.4.3.3. The sample unit shall be one shipping container. The lot size shall be the total number of shipping containers.

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4.4.3 Quality conformance tests and examinations.

4.4.3.1 Visual inspection. All film shall be inspected to the requirements of 3.7.

4.4.3.2 Physical property tests. The sample selected in accordance with 4.4.2.2 shall be used to prepare 3 specimens for normal temperature peel test (see 4.6.1) and 3 specimens for normal temperature flexure (see 4.6.7). The specimens shall be prepared as specified in the appropriate subparagraph of 4.3.4. Failure of any specimen to meet or exceed the minimum requirements specified in table I shall be cause to reject the lot represented by the specimen.

4.4.3.3 Packaging examination. Samples selected in accordance with 4.4.2.3.1 and 4.4.2.3.2 shall be visually examined to the applicable requirements in table II and all other requirements to determine conformance to section 5 of this specification. The acceptable quality level (AQL) for this inspection shall be 4.0 percent defective. In addition, shipping containers fully prepared for delivery shall be inspected for closure defects.

4.5 Test conditions.

4.5.1 Normal temperature. Normal temperature tests, when specified herein, shall be conducted at 70° to 80°F (21° to 27°C). Testing shall be initiated 10 +2, -0 minutes after the specimens have reached equilibrium at this temperature. The required time for the specimens to reach normal temperature equilibrium following conditioning shall be not less than 10 minutes nor more than 30 minutes.

4.5.2 Elevated temperature. The final testing temperature of all specimens for elevated temperature tests shall be those of the surface of the metal as close to the bonded area as possible. The temperature shall be determined with a thermocouple, firmly attached, in order to insure accuracy of the testing temperature and reproducibility of data. If radiant heating devices are used, the thermocouples shall be properly shielded. Specimens for the long-time elevated temperature tests may be placed in circulating air ovens for the 192-hour period, after which they shall be immediately transferred to the heating unit of the testing machine. Elevated temperature tests shall be conducted 10 +2, -0 minutes after the specimens in the testing chamber have reached temperature equilibrium at the specified temperature. The time required for the specimens to reach the specified temperature equilibrium shall not exceed the schedule specified in table III.

4.5.3 Low temperature. Low temperature test shall be conducted at -67° + 20°F (-55° + 10°C). Testing shall be initiated 10 +2, -0 minutes after the specimens have reached equilibrium at that temperature. The method for determining the temperature of the specimens and the time required for the specimens to reach temperature equilibrium shall be in accordance with 4.5.2.

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4.5.4 High humidity condition. Resistance to humidity exposure shall be determined after 30-days + 2-hours exposure of the specimens in a humidity cabinet in which the exposure zone of the closed humidity chamber is maintained at $120^{\circ} + 5^{\circ}\text{F}$ ($49^{\circ} + 2.8^{\circ}\text{C}$) and 95 to 100 percent relative humidity. The temperature in the chamber shall be recorded at least twice each working day. Condensate from one panel shall not drip upon any other panel. Distilled water or water containing not more than 200 parts per million of total solids shall be used to maintain the humidity. The test shall be continuous for the duration of the 30 day period. Continuous operation means that the chamber shall be closed and the humidity maintained continuously, except for the short daily interruptions necessary to inspect, rearrange, remove test panels, or to check or replenish the water in the reservoir. The test specimens shall be individually suspended vertically in the atmosphere above the water and shall not contact the sides of the container or other test specimens.

4.5.5 Fluid immersion conditions. Test specimens shall be immersed in turbine fuel conforming to JP-4 of MIL-T-5624 for 30-days + 2-hours. The fluid temperature shall be 70° to 80°F (21° to 27°C). All specimens shall be placed in the fluid container to insure full contact with the fluid while not contacting the other specimens.

4.6 Test methods.

4.6.1 Sandwich peel strength. Sandwich peel strength shall be determined in accordance with ASTM D 1781 using the apparatus and specimen shown in figure 1. Test specimens shall be prepared as specified in 4.3.4 and the applicable subparagraphs. For testing bonds having high-peel strengths in sandwich panels with low stiffness, additional stiffness may be added to the back face of the sandwich panel (see 6.4.3). Six peel test specimens shall be tested after normal conditioning (see 4.5.1).

4.6.2 Elevated temperature sandwich peel strength. Six sandwich peel test specimens shall be exposed to short-time elevated temperature conditioning in 4.5.2 at $180^{\circ} + 20^{\circ}\text{F}$ ($82^{\circ} + 10^{\circ}\text{C}$). Specimens shall be tested for peel strength (see 4.6.1) at the exposure temperature. The entire test apparatus and specimen shall be placed within the heating chamber. The length of straps and fittings may be reduced to fit within standard ovens.

4.6.3 Low temperature peel test. Six peel test specimens from 4.3.4.2 shall be conditioned as specified in 4.5.3. Testing shall be conducted at the exposure temperature in accordance with 4.6.1.

4.6.4 Flatwise tensile strength. Flatwise tensile strength determinations shall be made in accordance with ASTM C 297 and the following: Test specimens shall be in accordance with 4.3.4, 4.3.4.1 and 4.3.4.3. The tensile load shall be applied to the fixture at a constant rate of movement of the moveable head of the testing machine of not less than 0.015 and not more than 0.020 inch per minute until failure. The maximum load and type of failure shall be recorded. All failing loads shall be expressed in pounds per square inch of actual test area, calculated to the nearest 0.01 square inch. Six specimens shall be tested after normal temperature conditioning (see 4.5.1).

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4.6.5 Elevated temperature flatwise tensile strength. Six specimens (see 4.3.4.3) shall be exposed for short-time duration as specified in 4.5.2 at the applicable adhesive type temperature specified in table I. Testing shall be conducted as specified in 4.6.4 at the elevated temperature after conditioning as specified in 4.5.2.

4.6.6 Low temperature flatwise tensile strength. Six specimens shall be conditioned at $-67^{\circ} \pm 2^{\circ}\text{F}$ ($-55^{\circ} \pm 1^{\circ}\text{C}$) as specified in 4.5.3. Testing shall be conducted as specified in 4.6.4 at the low temperature.

4.6.7 Sandwich flexure test. Specimens prepared in accordance with 4.3.4.4 shall be tested for flexure in accordance with ASTM C 393, except that the specimens shall be tested in flexure over a 6 inch span with the load applied at the two third-span points as shown in figure 2. The round steel rods or pipes used to apply loads shall have a diameter not less than 1/4 nor more than 3/4 inch. The end support of the rounded knife edges shall swivel and be used with metal plates having rollers that will permit these plates to move during the flexure of the specimen. Span and third points shall be accurately located to within 0.01-inch. The specimens shall be loaded at a constant rate of the moveable head of the testing machine of not less than 0.015 nor more than 0.020 inch per minute until failure. Tests shall be made at the normal temperature conditions specified in 4.5.1. Only the maximum load required to fail the 3-inch wide specimen need be measured. The maximum load and type of failure shall be recorded. Six specimens shall be tested after normal temperature conditioning as specified in 4.5.1.

4.6.8 Elevated temperature sandwich flexure test. Six flexure specimens (see 4.3.4.4) shall be conditioned for short-time exposure and six for long-time exposure as specified in 4.5.2 and the applicable adhesive type temperature from table I. Testing shall be in accordance with 4.6.7 at the conditioning temperatures.

4.6.9 Low temperature sandwich flexure test. Six flexure specimens (see 4.3.4.4) shall be conditioned as specified in 4.5.3 and tested at the low temperature in accordance with 4.6.7.

4.6.10 Normal temperature creep deflection and flexure test. Six sandwich specimens, prepared in accordance with 4.3.4.4, shall be tested for conformance to table I. Creep deflection measurements shall be determined by using either an apparatus as specified for the flexure test (see figure 2) or other loading devices which will exert the constant load specified in table I on the test specimen specified. The load shall be applied 10 ± 2 , -0 minutes after the specimens have reached equilibrium. Within 25 to 30 seconds after loading, the center beam deflection shall be accurately measured to the nearest 0.001 inch. Creep deflection shall be measured at increments in time to establish creep deflection time curves not to exceed 192 hours. The difference between the final deflection readings shall be recorded as the creep deflection.

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4.6.11 Elevated temperature creep deflection and flexure tests. Six sandwich specimens shall be subjected to the creep deflection test in accordance with the general requirements specified in 4.6.10. The entire assembly shall be placed in a heating chamber maintained at the temperature specified in table 1, test 12, as applicable to the type.

4.6.12 Humidity exposure. Six flexure specimens (see 4.3.4.4) shall be tested for flexure at normal temperatures (see 4.6.7) after exposure as specified in 4.5.4. Testing shall commence immediately upon removal from the humidity environment.

4.6.13 Turbine fuel immersion. Six flexure specimens (see 4.3.4.4) shall be tested for flexure in accordance with 4.6.7 after exposure in turbine fuel specified in 4.5.5. The specimens shall be removed from the fluid, wiped clean and tested immediately.

5. PACKAGING

5.1 Preservation - packaging. Preservation - packaging shall be level A or Commercial, as specified (see 6.2).

5.1.1 Level A.

5.1.1.1 Unit packaging. Adhesives, in roll form as specified (see 6.2), shall be wrapped in a suitable release paper, then enclosed in hermetically sealed vapor barrier material conforming to MIL-F-22191, and individually packaged in a box conforming to PPP-B-636, W6c or W6s. Each box shall be waterproofed as specified for the weatherproofing of slotted boxes in accordance with the appendix of PPP-B-636. The adhesive is to be supplied in rolls of specified width (inches) and length (feet). (See 6.2c).

5.1.1.2 Intermediate packaging. Rolls of adhesive, packaged as specified in 5.1.1.1, shall be intermediate packaged in quantities of twelve (12) rolls (see 6.2) in boxes conforming to PPP-B-636, grade V3c.

5.1.2 Commercial. The adhesive film shall be packaged to afford protection against deterioration and damage from the supplier to the initial destination for immediate use. The supplier shall use his commercial practice providing it fulfills the requirements for this level.

5.2 Packing. Packing shall be level A or Commercial as specified (see 6.2).

5.2.1 Level A.

5.2.1.1 Adhesives. Adhesives, intermediate packaged as specified in 5.1.1.2, shall be packed in wood cleated plywood boxes conforming to PPP-B-601, overseas type, style optional, in quantities not to exceed the weight limitation of the container. Box closure and strapping shall be in accordance with the appendix to the box specification. Strapping shall be zinc coated.

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5.2.2 Commercial. Adhesives, packaged as specified in 5.1, shall be packed to assure carrier acceptance and safe delivery to destination at lowest rating in conformance to requirements of Uniform Freight Classification Rules or National Motor Freight Classification Rules, as applicable.

5.3 Marking. In addition to markings required by the contract or order, the interior and exterior shipping containers shall be marked in accordance with MIL-STD-129 and shall include the following:

ADHESIVE, FILM FORM, METALLIC STRUCTURAL SANDWICH CONSTRUCTION
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Type, class, and cure group
Date of manufacture (month and year)
Manufacturer's name and address
Manufacturer's product designation
Manufacturer's batch/lot identification
Contract number
Date of shipment
Expiration date
Manufacturer's recommended storage temperature range
Quantity contained
Film weight

6. NOTES

6.1 Intended use. Adhesives conforming to this specification are intended for bonding sandwich constructions of metal facings to metal core for use in structural airframe parts. Included in this is the bonding of the metal facings to metal components within the sandwich panels which must be cured under the same conditions as the sandwich panel. Fabrication and inspection will be in accordance with the requirements of MIL-A-83377. Parts or assemblies requiring the use of adhesives covered by this specification should be designed with consideration for the heat and pressure required during the bonding operations. The maximum curing pressures specified in 3.3.2.2 are necessary requirements for determining the suitability of an adhesive for general production use. However, shop facilities permitting higher pressure in accordance with the manufacturer's instructions should be used wherever practicable.

6.1.1 Any adhesive covered by this specification can be used for sandwich constructions other than metal to metal, provided the use of the adhesive is substantiated by the tests specified herein using the combination of the materials in question. For example, an adhesive covered by this specification can be used for bonding metal core to plastic facings, plastic core to plastic facings, and plastic inserts and edge members to plastic or metal facings when that adhesive has successfully passed testing using the specific material.

6.2 Ordering data.

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6.2.1 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number and date of this specification.
- b. Type, class, and cure group (see 1.2), adhesive code number (see 3.2.2).
- c. Length and width of film adhesive roll.
- d. Weight of adhesive film (psf)
- e. Curing conditions (cure group, see 1.2).
- f. Level of packaging and packing required (see 5.1 and 5.2).

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are at the time set for opening bids, qualified for inclusion in the applicable Qualified Products List whether or not such products have actually been so listed by that date. The attention of the suppliers is called to this requirement, and manufacturers are urged to arrange to have the products that they proposed to offer to the Federal Government, tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. The activity responsible for the Qualified Products List is the Naval Air Systems Command, Washington, DC 20361; however, information pertaining to qualification of products and letter of authorization for submittal of sample may be obtained from the Qualifying Laboratory - Commander, Naval Air Development Center, Warminster, PA 18974, Attention: ACSTD (Code 6062).

6.4 Fabrication and testing notes.

6.4.1 Cutting of test panels and specimens. Test panels and specimens should be cut in such a manner that vibration and heating of the specimen are kept to a minimum.

6.4.2 Type of fabrication of core. The expanded type of honeycomb core is preferable for the fabrication of the sandwich test panels in 4.3.4.2, because of its normally sharper edges and better bonding properties, but tests made with the corrugated type of core, smoothly cut, are acceptable.

6.4.3 Prevention of bending sandwich specimen in peel test. If, after a trial test, the peel resistance of the bond is found to be so high that the sandwich specimen bends appreciably during the test (see 4.6.1), a piece of 1/2 inch thick plywood can be suitably attached to the back face of the sandwich specimen to stiffen it.

6.4.4 Prevention of local failures in flexure test. If, after a trial test, it is found that local failure occurs under the load points during the sandwich flexure tests (see 4.6.7 through 4.6.9), 1 inch wide strips of thin plywood or other suitable thin materials may be used under these load points.

6.5 Batch. A batch shall consist of a homogeneous unit of adhesive manufactured at one time or representing a blend of several manufactured units of adhesive of the identical formulation which is used to prepare a lot of adhesive film.

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6.6 Changes from previous issue. Asterisks are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Custodians:

Army - MR
Navy - AS
AF - 99

Preparing activity:

Navy - AS

(Project No. 8040-0423)

Review activities:

Army - AR, AV, EL, ME
Air Force - 11
MISC - NSA

User activities:

Army - AT
Navy - OS, SH

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TABLE I Mechanical properties of bonded joints.

Test No	Test specimens required 3/	Adhesive type	Characteristics and conditions	Test para	Requirements 1/	
					Min average value	Min. individual value
1	6	I II III and IV	<u>Sandwich peel strength,</u> <u>lb in./in of width</u>	4.6 1	12.5	10
			Normal temperature 2/		10.0	7
					3.5	2
2	6	I and II III and IV	$180^{\circ} \pm 20^{\circ}\text{F}$ ($82^{\circ} \pm 10^{\circ}\text{C}$)	4.6 2	10	7
					3.5	2
3	6	I, II, III, IV	$-67^{\circ} \pm 20^{\circ}\text{F}$ ($-55^{\circ}\text{C} \pm 10^{\circ}\text{C}$)	4.6.3	10.0	6
4	6	I, II, III, IV	<u>Flatwise tensile</u> <u>strength psi</u>	4.6 4		
			Normal temperature 2/		750	600
5	6	I II III and IV	$180^{\circ} \pm 20^{\circ}\text{F}$ ($82^{\circ} \pm 10^{\circ}\text{C}$)	4.6 5	400	330
			$300^{\circ} \pm 50^{\circ}\text{F}$ ($149^{\circ} \pm 30^{\circ}\text{C}$)		350	315
			$500^{\circ} \pm 50^{\circ}\text{F}$ ($260^{\circ} \pm 30^{\circ}\text{C}$)		220	190
6	6	I, II, III, IV	$-67^{\circ} \pm 20^{\circ}\text{F}$ ($-55^{\circ} \pm 10^{\circ}\text{C}$)	4.6 6	800	650
7	6	I, II, III, IV	<u>Flexural strength</u> <u>(total load), lbs</u>	4.6 7		
			Normal temperature 2/		2,100	1,800
8	6	I II III and IV	$180^{\circ} \pm 20^{\circ}\text{F}$ ($82^{\circ} \pm 10^{\circ}\text{C}$)	4.6 8	1,275	1,150
			$300^{\circ} \pm 50^{\circ}\text{F}$ ($149^{\circ} \pm 30^{\circ}\text{C}$)		1,500	1,350
			$500^{\circ} \pm 50^{\circ}\text{F}$ ($260^{\circ} \pm 30^{\circ}\text{C}$)		1,200	1,080
9	6	I, II, III, IV	$-67^{\circ} \pm 20^{\circ}\text{F}$ ($-55^{\circ} \pm 10^{\circ}\text{C}$)	4.6.9	2,150	1,800

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TABLE I. Mechanical properties of bonded joints. (continued)

Test no	Test specimens required	Adhesive type	Characteristics and conditions	Test para	Requirements	
					Min average value	Min individual value
10	6	I, II and III, IV	Flexural strength after 192 hours exposure (total load), lbs $1100 \pm 20^\circ\text{F}$ ($820 \pm 10^\circ\text{C}$) $3000 \pm 50^\circ\text{F}$ ($1490 \pm 30^\circ\text{C}$) $5000 \pm 50^\circ\text{F}$ ($2600 \pm 30^\circ\text{C}$)	4.6.8	1,500 1,200 600	900 1,000 540
11	6	I, II, III, IV	Creep deflection in flexure when loaded for maximum of 192 hours, inch, max. deflection Normal temperature, 100 lb load \angle	4.6.10	0.025 in. max. deflection	
12	6	I, II and III, IV	$1800 \pm 20^\circ\text{F}$ ($820 \pm 10^\circ\text{C}$), 800 lb load $3000 \pm 50^\circ\text{F}$ ($1490 \pm 30^\circ\text{C}$), 1000 lb load $5000 \pm 50^\circ\text{F}$ ($2600 \pm 30^\circ\text{C}$), 500 lb load	4.6.11	0.05 in. max. deflection 0.05 in. max. deflection 0.05 in. max. deflection	
13	6	I, II, III, IV	Flexure strength after 30 days exposure (total load) lbs 75 to 100 percent relative humidity and $1200 \pm 20^\circ\text{F}$ ($490 \pm 10^\circ\text{C}$)	4.6.12	1,800	1,350
14	6	I, II, III, IV	To turbine fuel JP-4 of MIL-T-5624	4.6.13	1,800	1,350

1/ The number of specimens required by each qualifying test shall be tested and the results shall not be less than the minimum average and minimum individual value requirements. All strength values, including the average, and all data upon which these values are based, from both the initial tests and any retests, shall be reported.

2/ Normal temperature conditions in accordance with 4.5.1.

3/ Specimens required are per type undergoing qualification.

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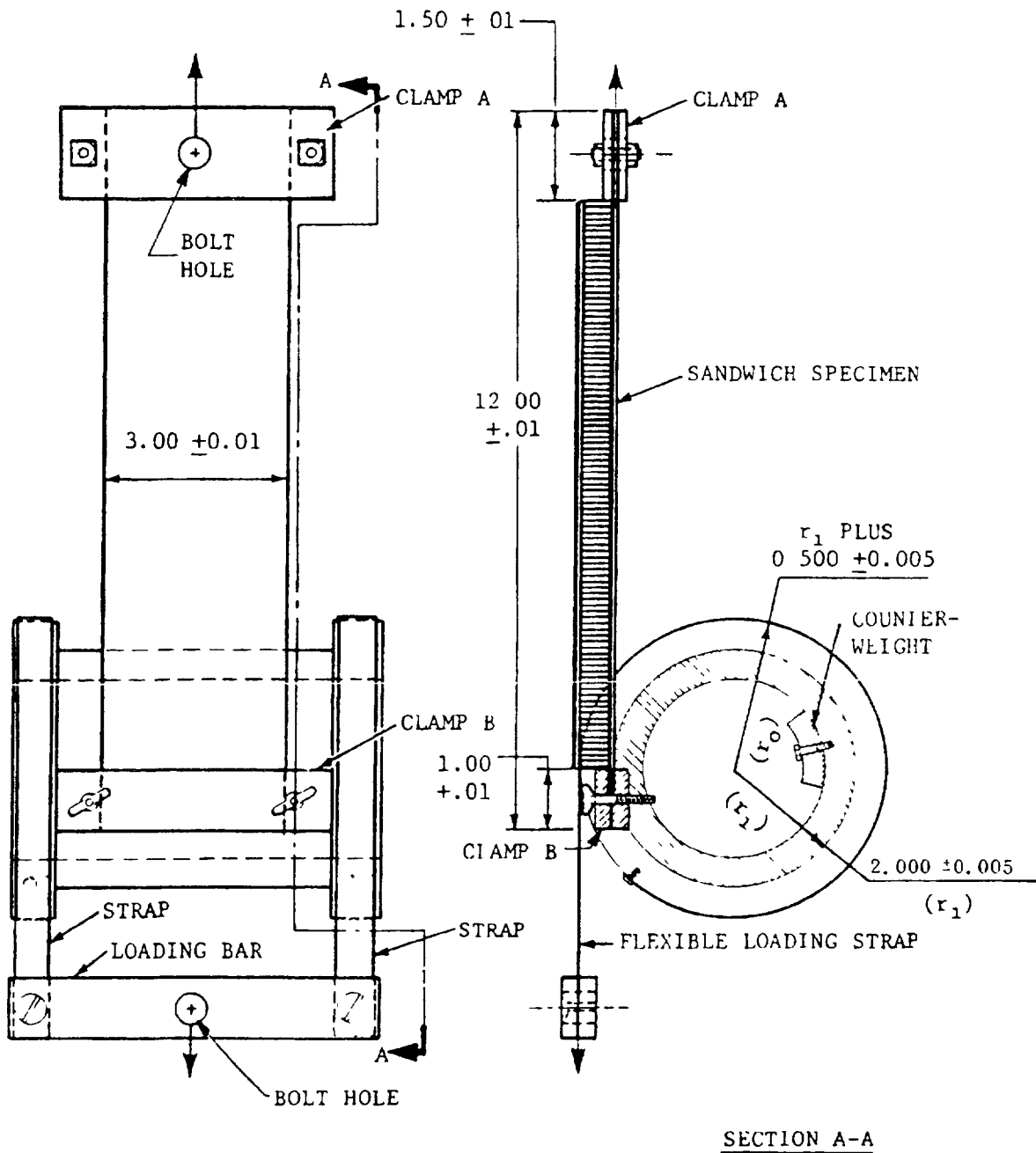
TABLE III. Packaging examination.

Examination	Defect
Packaging	Material or construction not as specified Components damaged, missing, or film not protected Unit package closure incomplete or damaged Not level required by contract or purchase order.
Packing	Not level required by contract or purchase order Any nonconforming component, incomplete closures Bulged or damaged shipping containers.
Count	Less than specified or indicated quantity per shipping containers
Markings	Unit package and packing - Omitted, illegible, incorrect, incomplete or not in accordance with contract requirements. Instruction sheet missing.

TABLE IV Specimens time to equilibrium

Test temperature	Time in minutes to equilibrium for	
	Short-time exposure	After long-time exposure
-67° ± 2°F (-55° ± 1°C)	30 ± 10	20 ± 10
120° ± 2°F (49° ± 1°C)	30 ± 10	20 ± 10
180° ± 2°F (82° ± 1°C)	30 ± 10	20 ± 10
300° ± 5°F (149° ± 3°C)	45 ± 10	20 ± 10
500° ± 5°F (260° ± 3°C)	60 ± 10	20 ± 10

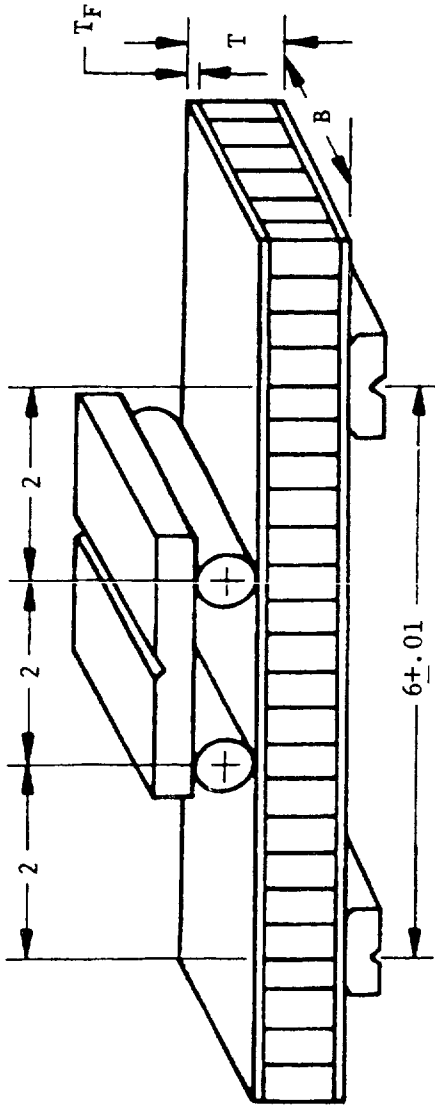
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DIMENSIONS IN INCHES. NOT COMPLETELY DIMENSIONED.
 r_1 = RADIUS OF DRUM TO MID-DEPTH OF SPECIMEN FACING.
 r_0 = RADIUS OF MID-DEPTH OF STRAP.

FIGURE 1 Type of apparatus suitable for making sandwich peel test.

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B = SPECIMEN

T = SPECIMEN THICKNESS

T = T_F = FACING THICKNESS

END SUPPORT PLATES ARE 1 BY 3 BY .250 INCHES WITH GROOVES FOR ALIGNMENT.
LOADED EDGES ARE ROUNDED TO .06 INCH RADIUS.
LOAD BARS ARE .500 INCH ROUND.

DIMENSIONS IN INCHES. TOLERANCES: AS INDICATED.

FIGURE 2. Method of loading for sandwich flexure testing.

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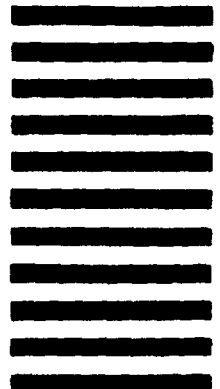
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